# SATS PLANNING CONFERENCE
# JUNE 22, 1999

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# STATE-OF-THE-ART IN GENERAL AVIATION AVIONICS


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**NASA Langley Research Center**

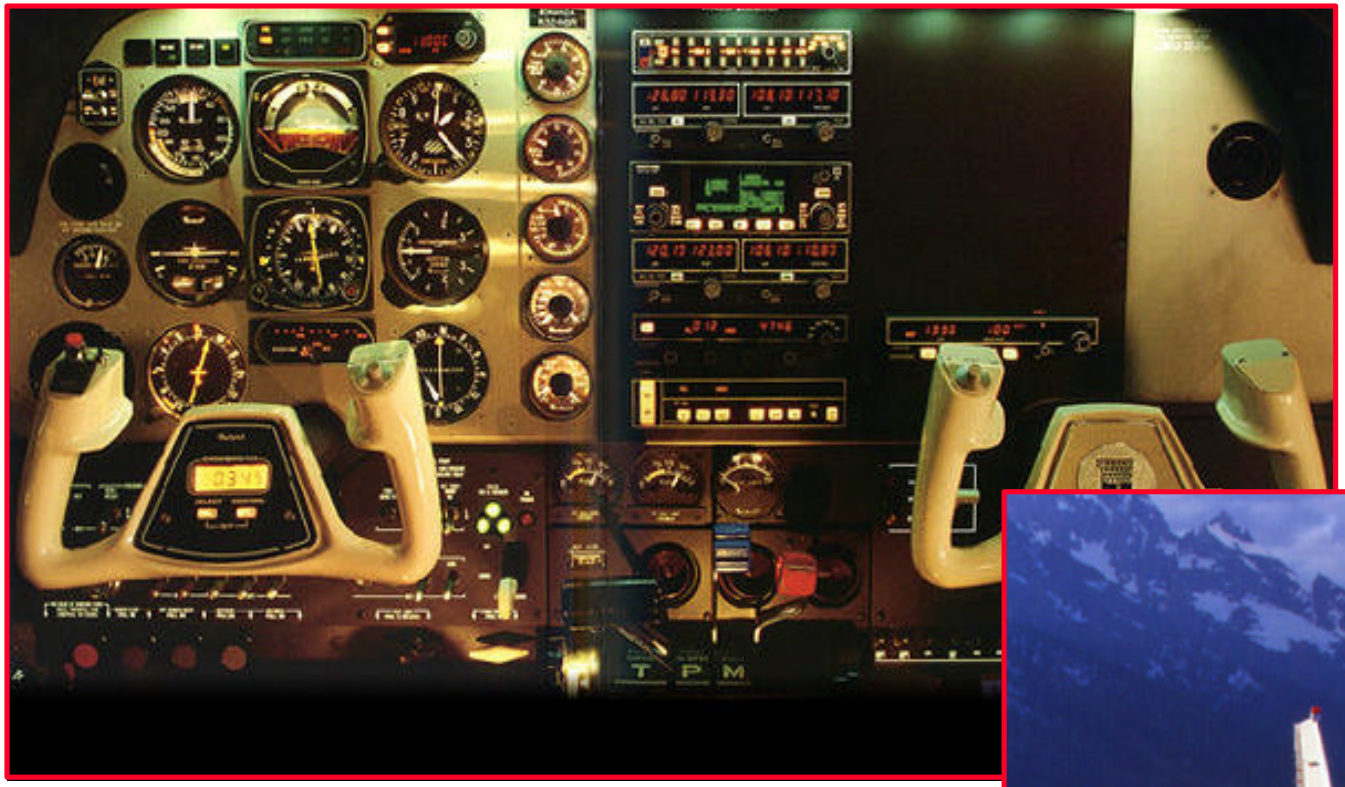
# OUTLINE

- **Background**
- **Advanced General Aviation Transport Experiments**
- **General Aviation Revitalization**
- **SATS Challenges in Avionics**

# STATE-OF-THE-ART….1948

# STATE-OF-THE-ART….1990's

# STATE-OF-THE-ART….1990's



# THE AGATE PROJECT

- **Consortium of Government, Industry, Universities, and Nonprofit Organizations**
- **Goal: Create the Technological Basis for Revitalization of the U.S. General Aviation (GA) Industry**
  - **Single-Pilot Flight Deck, Single-Engine Light GA Airplane**
  - **Mission of Point-to-Point On-Demand Transportation**
    - » **150 to 700 mile range**
    - » **"Near-all-weather" capability**
      - **CAT 1 ILS at over 5000 public use airports**
      - **Do not fly through thunderstorms**
      - **Do not fly through known ice without protection**
      - **Do not fly through moderate and severe turbulence**

# AGATE PRODUCTS

## GS&C's

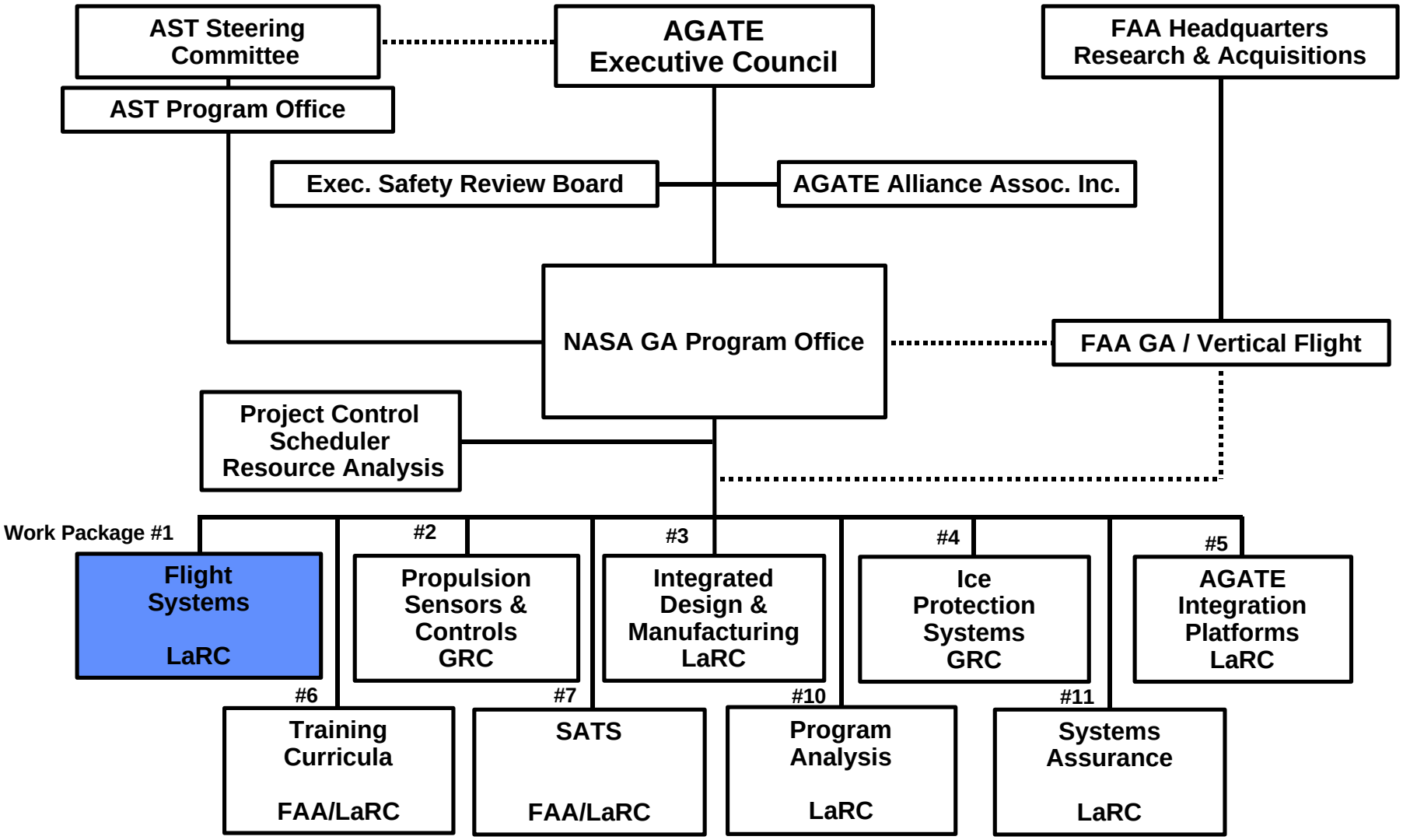
- Design Guidelines
- Systems Standards
- Certification Methods

# AGATE TIMELINE

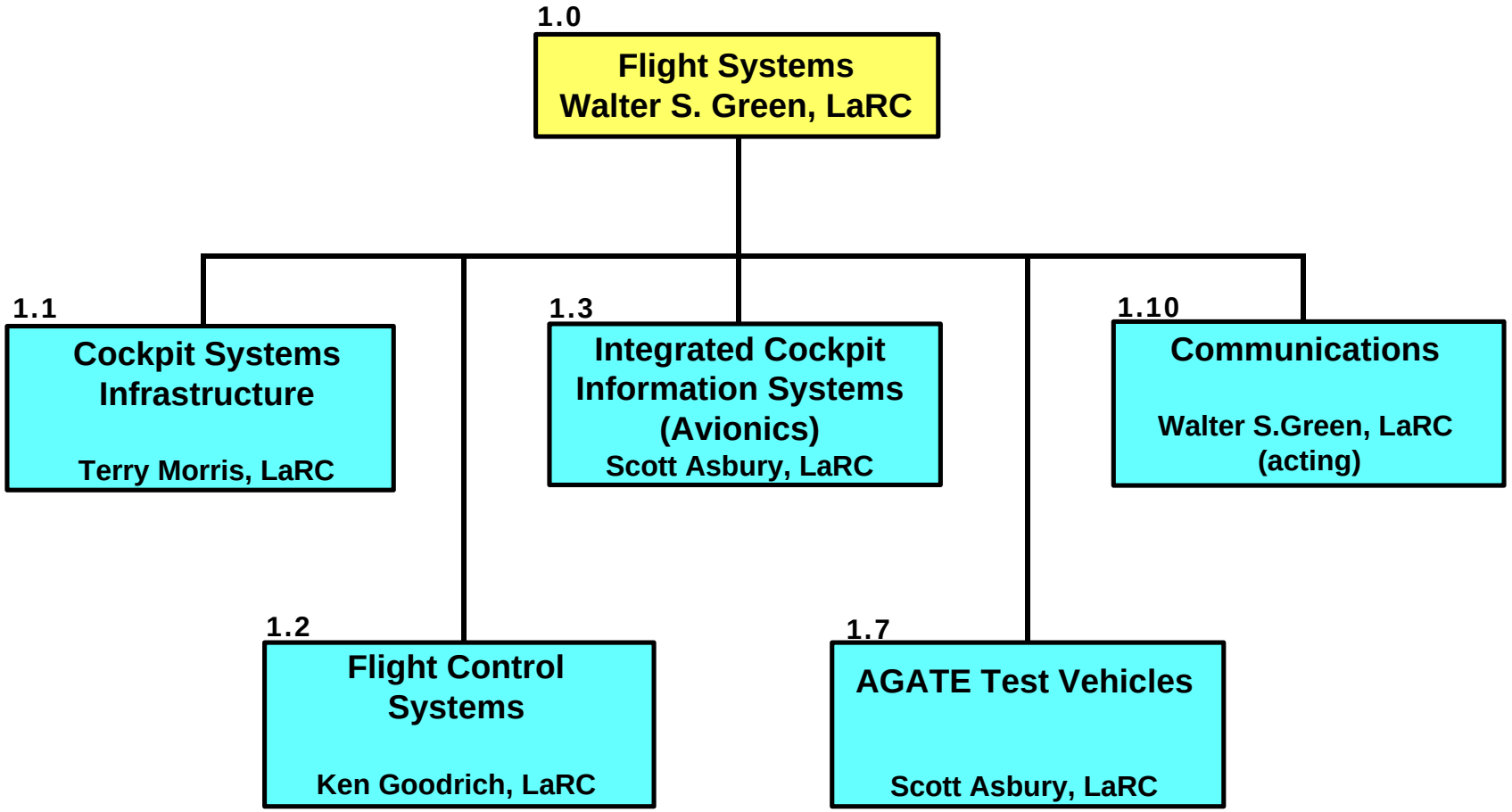
- Create Consortium
- Conduct Market Analysis
- Establish Requirements
- Identify Technology & Systems Options
- Develop & Evaluate Selected Alternatives
- Provide Design Guidelines, System Standards & Certification Methods

1994 — 2001

# AGATE ORGANIZATION



# FLIGHT SYSTEMS ORGANIZATION



# AGATE
# FLIGHT SYSTEMS OBJECTIVES

- **Develop Affordable, Integrated Controls and Displays to:**
  - **Improve pilot situational awareness**
  - **Reduce pilot work load**
  - **Reduce requirement for voice communication**
  - **Reduce time and cost to obtain and maintain safe "near-all-weather" flying skills**
- **Establish Standards and Certification Methods for New Technology Applications in GA Airplanes**
  - **Provide analytical and human factors support for regulatory changes and FAA Advisory Circulars**
  - **Provide technical analysis input to the RTCA and other standards bodies**

# FLIGHT SYSTEMS AREAS OF EMPHASIS

- **Infrastructure**
  - Databus
  - Avionics computer resource
- **Flight Controls**
  - Attitude and Heading Reference System (AHRS)
  - Auto-pilot display format
  - De-coupled flight controls
- **Cockpit Information Systems**
  - Integrated primary and multi-function displays
  - Highway-in-the-Sky (HITS) development
  - Nav, traffic, weather, flight plan, and system status standards
- **Communication**
  - Interoperable data link

# FLIGHT SYSTEMS AREAS OF EMPHASIS

- **AGATE Test Vehicles**
  - **AGATE architecture implementation**
    - » **De-coupled flight controls**
    - » **HITS display**
    - » **Emergency auto-land capability**
    - » **Data link communications**

# THE AGATE COCKPIT


# AGATE COCKPIT CHARACTERISTICS

- **Certifiable Advanced Technology Architecture**
  - **Computer-driven, flat-panel displays**
    - » **Electronic primary flight display (PFD) with HITS flight path depiction**
    - » **Integrated, graphical multi-function display (MFD) of navigation, weather, traffic, flight plan, and system status information**
  - **De-coupled flight controls**
  - **Databus with plug and play capability**
  - **GPS-based navigation**
  - **Information transfers via data link**
  - **Emergency auto-land capability**
  - **Electronic, single-lever power control**

# AGATE COCKPIT ADVANTAGES

- **Increased Situational Awareness for Improved Safety**
  - **Flight plan, position, weather, traffic, terrain, airspace, and systems status information provided via:**
    - » **HITS graphical PFD depiction with terrain**
    - » **Integrated MFD with decision aiding**
  - **Minimum recoding of information**
  - **Less demand on short-term memory for operations**
- **Less Demand on Long-Term Memory for Proficiency**
- **Minimum Training Time and Cost**
- **Simplified Emergency Procedures**
- **Emergency Auto-Land Capability**

# FLIGHT SYSTEMS PRODUCTS

- **AGATE GS&Cs for:**
  - **Databus**
  - **Computer resource**
  - **De-coupled flight controls**
  - **Low-cost GPS-based AHRS**
  - **Integrated displays with navigation, weather, traffic, flight planning, and systems status**
  - **Highway-in-the-Sky**
  - **Data link communications**
  - **Emergency auto-land capability**
- **Revised FAA Advisory Circulars**
  - **AC 23.1309**
  - **AC 23.1311**

# REVISED AC 23.1309

- **EQUIPMENT, SYSTEMS, AND INSTALLATIONS IN PART 23 AIRPLANES, REVISED MARCH 1999**
  - **Previous certification standard was unrealistic for GA**
    - » **Based on standards developed for transport category aircraft**
    - » **Required $10^9$ reliability regardless of safety implications**
  - **New standard allows affordable certification (under Title 14 CFR Part 23) of new technologies that:**
    - » **Improve pilot situational awareness (attitude/position/weather/traffic)**
    - » **Address terrain, traffic, and weather related accidents**
  - **Accomplished by AIR AGATE (FAA Small Airplane Directorate) and AGATE Flight Systems Team**

# REVISED AC 23.1311

- **INSTALLATION OF ELECTRONIC DISPLAYS IN PART 23 AIRPLANES, REVISED MARCH 1999**
  - **Allows affordable certification of the installation of electronic displays in Part 23 airplanes**
  - **Allows approval of new type design or a change in type design through TC, ATC, or STC**
  - **Accomplished by AIR AGATE (FAA Small Airplane Directorate) and AGATE Flight Systems Team**

# GA REVITALIZED

- **The Evidence is Everywhere!**
  - **2 New GA aircraft Type Certificates in 1999 (first in 15 years)**
    - » **Cirrus SR-20**
    - » **Lancair Columbia 300**
  - **Increased R&D expenditures in GA**
  - **Increased sales**
  - **Advanced avionics introduced to the market**
  - **Increased student pilot starts**
  - **Increased public awareness of GA as a transportation solution**

# CIRRUS SR-20

- Single-lever power control
- Multi-function display
- Ballistic airframe parachute
- Data link capability
- Improved crashworthiness

# LANCAIR COLUMBIA 300

- Multi-function display
- Data link capability
- Improved crashworthiness

# COMPANIES DEVELOPING STATE-OF-THE-ART GA AVIONICS


AVROTEC

UPS Aviation Technologies SM
A subsidiary of United Parcel Service

Archangel SYSTEMS INC

AlliedSignal AEROSPACE

AVIDYNE

NORTHSTAR TECHNOLOGIES • A Division of CMC Electronics, Inc.

SANDEL AVIONICS

Seagull Technology

KING

JEPPESEN

ORBCOMM
GLOBAL DATA & MESSAGING

MAGELLAN

BFGoodrich

ECHO FLIGHT

ARNAV

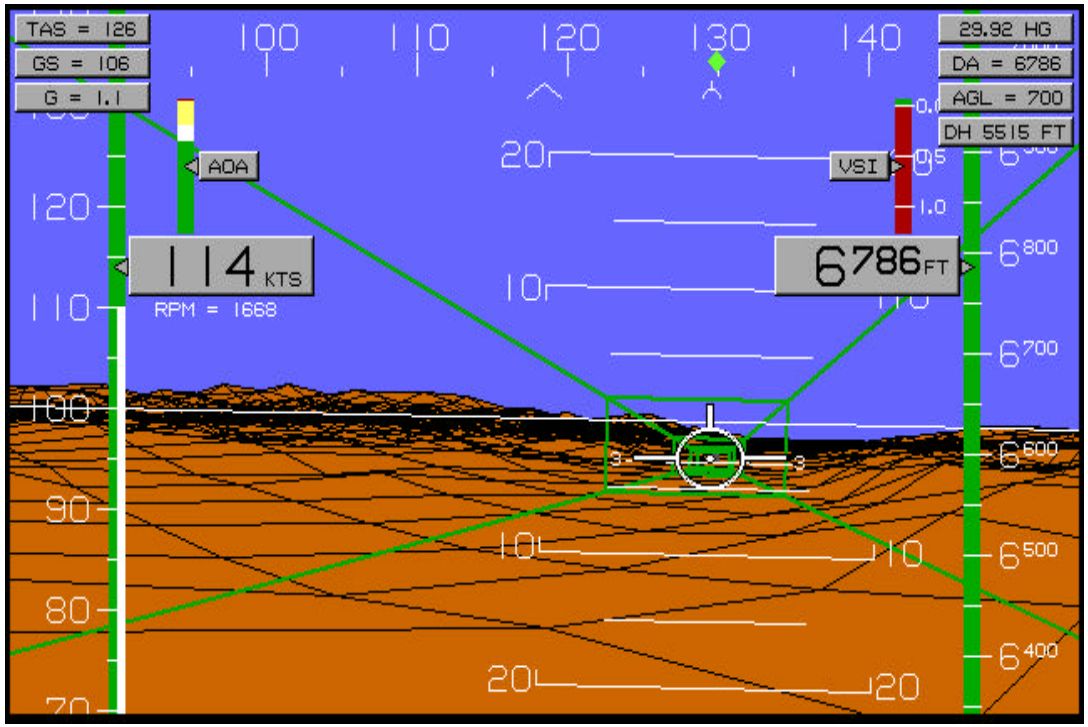
SIERRA FLIGHT SYSTEMS
ULTIMATE SITUATIONAL AWARENESS

NavRadio

# PRIMARY FLIGHT DISPLAYS

- **Sierra Flight Systems EFIS PFD**
  - 5x8-inch color display
  - Ruggedized Pentium II 233MHz CPU
  - Moving map display
  - Engine display
  - Air data computer
  - Solid-state gyro
  - GPS receiver
- **Experimental**

SIERRA FLIGHT SYSTEMS



# PRIMARY FLIGHT DISPLAYS

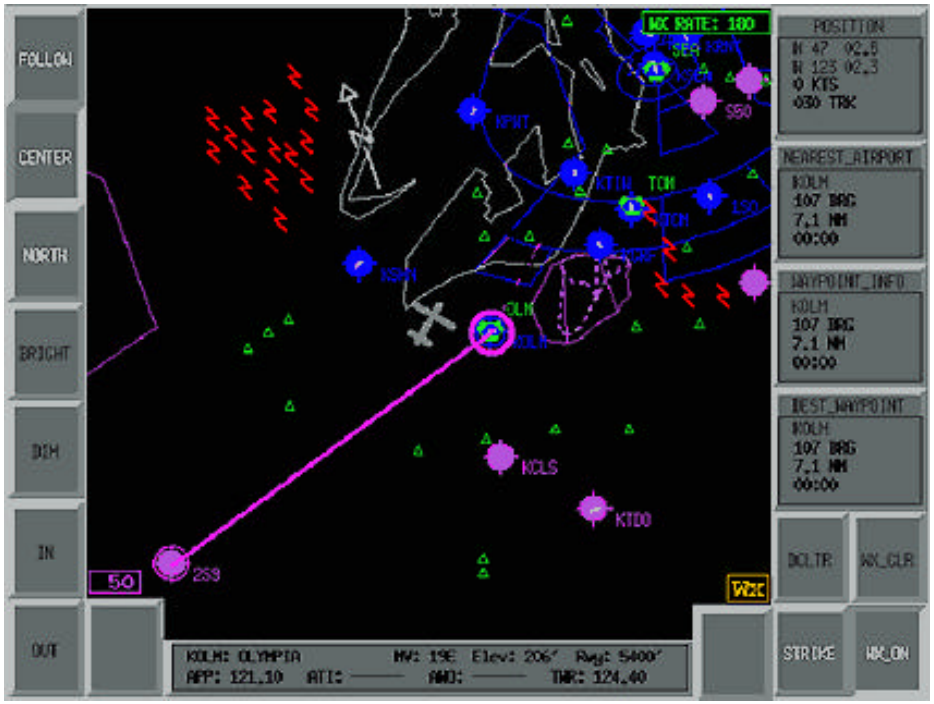
- **Archangel Systems, Inc. EFIS PFD**
  - 8.5x11.25-inch touch-screen 640x480 LCD
  - Engine Indicating and Crew Alerting Systems (EICAS)
  - Solid-state AHRS
  - Air data system
  - Engine data system
  - Fuel data system
  - GPS receiver
- **Experimental**

Archangel SYSTEMS INC

# MULTI-FUNCTION DISPLAYS

- **Archangel Systems, Inc. Cockpit Display System**
  - 8.5x11.25-inch touch-screen 640x480 LCD
  - GPS moving map display
  - ARNAV data link weather
  - Stormscope compatible
  - Ryan TCAD traffic
  - Flight planning
- **FAA Certified**

Archangel SYSTEMS INC



# MULTI-FUNCTION DISPLAYS

- **Garmin GNS-430 MFD**
  - 2x4-inch 128x240 LCD display
  - IFR approved GPS navigation
  - VOR navigation
  - VHF communication
  - ILS localizer and glideslope
  - Moving map color graphics
  - Jeppesen aviation database
  - Internal land data
- **FAA Certified**

# MULTI-FUNCTION DISPLAYS

- **Avidyne Flight Situation Display**
  - 5-inch diagonal 320x234 LCD display
  - GPS moving map
  - IFR enroute and VFR charts
  - Traffic (TCAS 1/ Ryan TCAD) interface
  - Stormscope interface
  - Weather radar interface
  - Weather data link
- **FAA Certified**

AVIDYNE

# MULTI-FUNCTION DISPLAYS

- **ARNAV MFD-5200**
  - 5-inch diagonal LCD display
  - GPS VFR/IFR moving map
  - Terrain obstruction proximity system (look around/look ahead)
  - Geographic database
  - Flight planning
  - Electronic checklist
  - Stormscope interface
  - Weather data link
  - EICAS
- **FAA Certified**

# MULTI-FUNCTION DISPLAYS

UPS Aviation Technologies SM
A subsidiary of United Parcel Service

- **Apollo MX-20 MFD**
  - 6-inch 640x480 LCD display
  - Terrain database coupled with GPS position and baro altitude inputs
  - VFR/IFR vector based moving map
  - Terrain awareness charting/alerting
  - Stormscope interface
  - Pilot-selectable custom displays
  - Flight planning
  - Future upgrades for data link
- **Certification by October 1999**

# PORTABLE AVIONICS

- **EchoFlight EchoMap Windows Software**
  - GPS moving map navigation
  - ORBCOMM LEO satellite data link
  - In-flight weather
  - 2-way e-mail
  - Position reporting


ORBCOMM
GLOBAL DATA & MESSAGING

eCHO FLIGHT

# PORTABLE AVIONICS

- **AvroTec Flight Monitor**
  - 10.4-inch diagonal 640x480 LCD display w/touchscreen
  - Pentium CPU w/Windows 95 or NT
  - GPS moving map
  - Flight planning
  - Approach plates
  - Electronic checklists
  - Weather data link
- **Certified Panel Mount Available**

AVROTEC

# PORTABLE AVIONICS

- **Northstar CT-1000 Cockpit Organizer**
  - 6.4-inch 800x600 LCD display w/mouse, remote keyboard
  - Pentium II CPU w/Windows 95 or 98
  - GPS moving map
  - Terrain avoidance
  - Approach plates
  - Charts
  - Internet access


NORTHSTAR TECHNOLOGIES • A Division of CMC Electronics, Inc.

# GA FLIGHT DECK CHALLENGES

- **Safety: Certifiable State-of-the Art Technologies**
  - Integrated displays with synthetic vision
  - De-coupled flight controls
  - Ride quality
- **Affordability: Produced for Volume Consumption**
  - Sensors and and processors
  - Databus
  - Heads-up displays
  - Software certification
  - Data link communication (VDL Mode 3)
- **Ease of Use: Intuitive, Integrated Cockpit Systems**
  - Minimization of training/retraining time and cost
  - Human factors considerations

# STATE-OF-THE-ART….2007